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## OUR MINERAL RESOURCES

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Abundance, variety and wide distribution characterize our country's mineral heritage. Large as are the stores of essential minerals, they, however, are not illimitable, and widespread as is their occurrence, nevertheless the most valuable minerals are somewhat unevenly distributed. The recognition of these limiting factors prompts the thorough study of our mineral wealth quantitatively and geographically if we would comprehend the true basis of the nation's industrial life.

An inventory of the mineral resources of the nation recently made public by the National Conservation Commission owes its chief value to the fact that the data used had been in preparation for more than a score of years. The appreciation by Congress of the importance to the nation of its mineral resources led to the establishment of the United States Geological Survey thirty years ago, and this bureau, in its explorations and investigations, had accumulated quantitative data that became readily available at the time of popular awakening to the needs of national conservation.

The distribution of mineral wealth depends on geologic factors, and different geologic provinces are characterized by deposits of different minerals. Herein lies the practical value of much of purely geologic study. Thus, an important part of the Survey's work through these years has been to keep the country informed as to the occurrence of economic minerals.

The facts as to the distribution of mineral wealth are of practical value because of the vital connection between such geographic distribution and the development of manufactures and commerce. Precedence is given to manufactures because this industry rather than commerce should first feel the creative influence of mineral wealth. The metallurgical, clay-working, structural and chemical industries constitute the web and woof of industrial prosperity, and to a large degree it is only the disregard of the principles of political economy that permits the export of raw material beyond the bound-

aries of state or nation. Free trade among the states of this Union has developed great interstate industries and internal commerce on a grand scale, but this phenomenal national development should not blind the people of the individual states to the advantages of local utilization of their own mineral resources. An illustration of this local utilization is seen in the new industrial South, which is possible because the South has always possessed mineral wealth.

The ten most important mineral products in the United States, in the order of value of annual output, are coal, iron, copper, clay products, petroleum, gold, stone, cement, natural gas and lead. For certain of these minerals the inventory by the Survey presents estimates of the supply with which the nation's needs are to be met. For others, especially clay products and cement, the question of the supply of raw material from which they are produced is of little moment compared with that of the availability of the fuels necessary for the processes of manufacture.

Of nearly equal importance with the factor of abundance of these mineral resources is that of distribution. In the first place, the widespread distribution of the raw material makes possible an industrial nation in which every state and territory has some share in the mineral production. Only three states had a mineral output last year valued at less than a million dollars, and twelve states had a production valued at over fifty million dollars each. Again, no state or section appears to have a monopoly of the mineral industry. While "progressive Pennsylvania," with its total mineral product nearly one-third that of the whole country, leads in coal, cement, stone and natural gas by large margins, another state, Minnesota, leads in iron ore; another, Arizona in copper; another, Ohio in clay products; Oklahoma in petroleum; Colorado in both gold and silver, and Missouri in both lead and zinc. Furthermore, the centers of production are ever shifting. For instance, in 1900 the primacy in quantity of petroleum produced passed from Ohio to California, thence in 1907 to Oklahoma, and within a year, in copper production, Montana had given place to Arizona, in lead Idaho to Missouri, and in silver Montana to Colorado. It is evident that we cannot prophesy the future progress of any industry unless we can determine the centers of the mineral reserves, for it will be toward these centers that industry will trend.

Our country's pre-eminence in supply of mineral fuels consti-

tutes its chief national asset. Coal occurs in all but fourteen states, and the far West and the South rival the East in their stores of petroleum and natural gas. A total area of nearly half a million square miles is underlain by coal beds. This is over sixteen per cent. of the area of the United States, not including Alaska, which has her own coal deposits. Of this area the anthracite coal fields of Pennsylvania, the product of which is of such importance in the eastern markets, constitute less than one-tenth of one per cent.

The tonnage estimates by Mr. M. R. Campbell, the geologist in charge of the Geological Survey field work in mineral fuels, indicate that the country's coal supply is represented by over three million million (3,157,243,000,000) tons. Of this amount nearly one-half (1,474,018,000,000 tons) is accessible and available for mining under present conditions; a third, or approximately one million million (1,153,225,000,000) tons, is accessible only with difficulty and thus represents a reserve that may become available whenever the increased demand warrants the more expensive mining operations necessary for its production. The remaining 530,000,000,000 tons include lower grade sub-bituminous and lignite coals, which, though easily accessible, are not at present in demand.

The tables prepared by Mr. Campbell show that of the coal deposits workable under present conditions, eighty-five per cent. is the higher grade coal, anthracite and bituminous, the remainder being sub-bituminous and lignite. Of the total supply the anthracite and bituminous coal also represent the largest areas, or 250,000 square miles, the sub-bituminous 97,000 square miles and lignite 148,000 square miles. These areas are distributed over six provinces, which rank in order of area as follows: Interior, Northern Great Plains, Rocky Mountain, Gulf, Eastern and Pacific Coast. In order of tonnage, however, the Eastern province, with its fourteen per cent. of area, ranks first, containing over thirty per cent. of the accessible coal, and indeed forty-three per cent. of the available supply, followed by the Northern Great Plains and the Rocky Mountain provinces, then by the Interior province, which if only the higher grades of coal were considered would stand second, the coal in the Northern Great Plains province being largely lignite and that in the Rocky Mountain province to a considerable extent sub-bituminous coal.

If in the consideration of the geographic distribution of the na-  
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tion's coal reserves a proper correction is applied to the estimated tonnage on account of the difference in heating value of the several varieties of coal, the geographical center of the coal deposits of the United States is at a point in southeastern Nebraska, in latitude forty degrees, twenty-five minutes, longitude ninety-six degrees, fifty-nine minutes.

The world's coal reserve cannot be even approximately estimated. Of the other countries which contribute to the world's production of coal few are believed to possess deposits at all comparable with those of this country. Since the days of von Richthofen's estimate of the coal resources of North China that country has been looked upon as possessing a reserve upon which other nations may draw when the coal supply of Europe and America shall run low. Mr. Bailey Willis' recent estimate on the coal of North China puts the figures at 605 billion tons, with the qualifying statement that this may be a hundred billion tons too much or too little. Such a reserve is fairly comparable with the total amount of coal in the Appalachian coal fields as estimated by Mr. Campbell. In short, the coal fields of Southern, Western and Northern China are sufficient only for the future needs of the great civilization which the Chinese will surely develop.

This glance at the world's reserves of coal shows plainly not only that the United States leads all other countries in production, our annual output being nearly forty per cent. of the total, but also that it possesses the greatest reserves. Yet in respect to no mineral is there greater need to emphasize the folly of exporting the raw material. Let us keep our coal at home and with it manufacture whatever the world needs.

Petroleum and natural gas must be considered together with regard to their distribution. The areas in which they are found are scattered over twenty-two states and aggregate nearly 9000 square miles, in six great petroleum fields. Eighteen states produced petroleum last year and nineteen states produced natural gas. The six known petroleum fields rank as follows in order of reserve: California, Appalachian, Lima-Indiana, Mid-Continent, Illinois and Gulf. Dr. David T. Day, of the United States Geological Survey, estimated the total probable yield of these and minor fields at fifteen to twenty-five billion barrels.

An estimate of the country's reserve of natural gas is much

more difficult. Dr. Day has compiled all the data relating to pressure in the various fields, from which he concludes that the duration of high pressure in the known fields is very short. On the other hand, the yield from low pressure wells is persistent and he therefore estimates the probable duration of the supply of natural gas in these words:

"This industrial enterprise of pumping natural gas in order to utilize the entire supply is the most hopeful element in the outlook for a continued supply. It is this feature which made possible the use of a larger quantity of natural gas last year than the year before. The outlook is that natural gas will be utilized for as long a period as has already elapsed since the industry began, with the greater part to be furnished by the Mid-Continent field."

The iron ore supplies of the United States rank second to the coal reserves in national importance. Although iron is one of the most abundant elements in nature, workable deposits of iron ores are not so widely distributed as might be expected. Iron ore is at present produced in only twenty-nine of the forty-eight states and territories, and more than two-thirds of the production comes from two states, Minnesota and Michigan. Dr. C. W. Hayes, the chief geologist of the Survey, in making an inventory of the iron ore supplies, has called attention to the fact that an understanding of the chemical and geologic classification of the iron ores is essential to the appreciation of the limitations and uncertainties of any estimate. In the case of the bedded ores, an approximation can be made comparable with the estimates of coal beds, but on the other hand, in the case of concentration and replacement deposits, the degree of uncertainty in any estimates is much greater.

Dr. Hayes' tonnage estimate of the iron ore deposits available for reduction under present mining and metallurgical conditions is nearly five billion (4,784,930,000) long tons, of which nearly three-quarters is credited to the Lake Superior hematite ores. The Clinton and other ores of the Southeastern district take second rank, the brown ores of the Mississippi Valley third, and the magnetite and Clinton ores of the Northeastern district fourth. Of lower grade ores, which are considered not available under present conditions, it is estimated that there are in the country nearly seventy-five billion tons, of which the largest part again consists of the hematite ores of the Lake Superior region. The relative import-

ance of our country's supplies of iron ore is indicated by comparison with the foreign supplies of iron ore believed to be sufficiently high grade and accessible to render them available for the iron industry of the United States. The total estimate for such deposits in Canada, Newfoundland, Mexico and Cuba is only one and one-half billion long tons, or considerably less than one-half of the available supply in the Lake Superior district alone.

The resources of the United States in the precious metals, as well as in copper, lead and zinc, are much less easily estimated than the supplies of either coal or iron. Although deposits of the precious and base metals are widely but sporadically distributed, occurring in all of the western states and many of the eastern states, yet no large areas are underlain by extensive ore deposits of these metals.

On the basis of investigations by the geologists of the United States Geological Survey, Mr. Waldemar Lindgren states that "to give definite figures representing our metal supply is quite out of the question." In the case of silver, copper and zinc, the reserves are large enough to warrant the expectation that a moderate rate of increase in production can be maintained probably for twenty years or more. In the case of lead, a greatly increased production is regarded as improbable.

Mr. Lindgren believes that the reserves in gold in the United States are great, although only for placer gold is even a rough estimate possible. With continuance of present methods of working and present wages, the placers are estimated to contain one billion dollars of reclaimable gold.

The silver reserves cannot be considered apart from the ores of gold, lead and copper. Over two-thirds of the silver produced in the United States comes from lead and copper ores, and a large proportion of it might properly be regarded as a by-product. From this Mr. Lindgren regards it as "evident that the present supply of silver is assured as long as the mining of lead and copper ores as well as quartzose gold continues on the present scale."

Any attempt to estimate the country's mineral wealth must convince us of the vital importance of utilizing most efficiently these resources, which are so essential to the nation's welfare. In view of the rapidly increasing demand upon these supplies it also becomes imperative that strenuous effort should be made to discover new

sources of the mineral fuels and ores. Thus alone can optimism be justified. Only as geologic explorations and mining operations uncover new deposits and block out known reserves can the United States with the continuance of its industrial development avoid facing the sure exhaustion of the supply of certain important minerals within this century.